for the economic entomologist and not for the medical man; or, at the very least, for the individual who does not yet exist, namely, the medical man trained as an entomologist. It is true that the practise of the results obtained by the research of medical entomologists may eventually be placed in the hands of men of lesser training or of men who possess other sanitary qualifications, such as the sanitary engineers, but the entomologist is a vital link in the chain. Entomologists, as such, will receive more and more consideration from sanitarians, especially in Army circles, as is indicated by the fact that, from a zero beginning in 1914, at the present time with each sanitary unit of seventy in the expeditionary forces of Great Britain there are two trained entomologists.

I might easily have prepared a paper of ten times the length of this and adding to its effectiveness, but other speakers are waiting to add their expert testimony to the enormous "value of zoology to the welfare of humanity." L. O. Howard

THE STATUS OF PHYSIOLOGY IN AMERICA

In a recent issue of our most widely read medical journal[1] there is presented an arraignment of modern biology which can not be passed by without serious consideration. This is so not because the writer of the review has presented the case exhaustively, or even fairly, but because the statements are commonly made and therefore deserve examination.

Modern biology is a composite, its several components derived from the following sources:

1. Traditional natural history of pre-Agassiz times.
2. The laboratory period of Agassiz.
3. The morphological period of Darwinian corroboration and consequences of the "Origin of Species."
4. The newer physiological aspects, introduced by the experimental school.
5. The dictations of the professional schools—medical, agricultural, etc.

Of the two great divisions, botany and zoology, the former has exhibited a more catholicity of view. Unlike zoology, the curricula of departments of plant study offer a more complete survey of the essential aspects of the subject. Both the functional as well as the morphological divisions are presented, for a typical curriculum of botany includes not only the morphological studies, similar to those of the department of zoology, but an integrated division of plant physiology, part and parcel of the department. To find an equivalent to this state of affairs in zoology, one must confine himself to a comparatively few of our institutions of learning. A typical case is presented by Princeton, and the result, indicated by the character of investigations produced from the department of biology of that university, has apparently justified the incorporation of functional study into the department. However, such instances are the exception rather than the rule and the number of institutions which embody this idea increase at a very low ratio from year to year.

The arrangement which is practised in many institutions is that which is exemplified by Columbia University. The department of zoology includes a professor of experimental biology and the courses presented by him are physiological, to be sure; yet these courses are advanced and are specialized for certain research work with which the department has been identified since 1904. For the undergraduate, nothing is available as far as a survey of functional zoology is concerned; that work is relegated to the medical school. In this respect, as we have said before, Columbia is typical inasmuch as the zoologist *leaves to the medical school the functional aspects of his science.*

Owing to the growing potency of the fifth factor mentioned above in our enumeration of the various components of modern biology, this condition of affairs is growing *pari passu* At California, where traditionally the depart-

[1] *Journal of the American Medical Association*, September 29, 1917, column Book Notices.

ment of physiology was general in its bearing, to-day we find it incorporated under the medical components of the university. Now there is nothing more evident to one who takes the trouble to investigate for himself than that the medical school is distinctly a vocational element, participating seriously in the modern "Zweckmässigkeit" or teleology which is insinuating itself more and more into our social fabric. In many ways, this is as it should be. Medicine, besides being a science, or composite of all the sciences as far as they can be made to bear upon human welfare, is likewise an art; and the practical aspects hold sway more tenaciously in the country at large than in some of our eastern medical institutions, such as Johns Hopkins, so that one must not judge of the spirit of medicine from a few chosen, advanced institutions such as the one we have mentioned. In fact, the pure science leanings of Johns Hopkins and other medical schools have been utilized in certain quarters as destructive criticisms of these institutions in their rôle as purveyers of medical training. More and more the intensely practical. "fruit-gathering" functions of the medical school are being emphasized.

Now all this has direct bearing upon the matter in hand. We have seen that zoology, typically, leaves to the medical school the functional side of its work. We have seen, too, that the typical aspect of the medical school is teleological, the end being the production of practical physicians. Consequently, the physiology of the medical school is attuned to the obtaining of results bearing directly upon human material. Muscle-nerve preparations are paramount upon the one side, metabolism studies upon the other. The zoological, that is the comparative, or general aspects of the living thing are approached casually. In the nature of the case, this must be so; *the problems of the medical physiologist are succinct and different from those of the zoologist.* It is to be considered an imposition for this condition of affairs to exist, for the medical physiologist gains little from his associations with the student from the department of zoology, whereas the zoologist gains materially from the association, yet so crowded and interdigitated are the various activities of the medical school that, save in a few cases, it is stealing the time from the professor and assistants to handle the zoological physiologists. Of far greater importance, however, from the side of efficiency is this: The zoological student gains the impression that the fundaments of the study of living functions can be gained from the presentations of the medical physiologist who deals with human and mammalian material. In common parlance, he is not getting his money's worth.

Physiology, then, falls into the following distinct groups:

1. General physiology, found in such isolated examples as may be culled by a perusal of the catalogs of our universities and colleges.
2. Botanical physiology, a part of departments of botany.
3. Zoological physiology, rarely presented as such.
4. Applied physiology:
   (*a*) Medical physiology.
   (*b*) Agricultural physiology, etc.

The statement is frequently made by applied physiologists that they are presenting the subject in a broad way and making what is essentially "general or biological physiology" out of their work. Nothing is more evident from such statements than that there is extant a distinct failure to grasp what is meant by the terms general or biological physiology. Let us take an example: One of the most successful teachers and men of research in physiology to-day presents an opening course in physiology. The content of the course consists of the familiar experiments in muscle-nerve physiology, as a background; why is not the muscle-nerve preparation sufficient to demonstrate the essentials of contraction, irritability, etc., which are the fundamental characteristics of protoplasm everywhere? Is there anything more "general" or more "biological"? The answer may be given in various ways, but scarcely save in the positive. There are many ways of presenting more fundamental factors, for in the first place, while

contraction is indeed one of the fundamental properties of living beings, you have selected in the muscle-nerve preparation a highly specialized mechanism which may have nothing essentially to do with contraction as it occurs in more undifferentiated protoplasm; the fact that this same professor presents, in connection with the muscle-nerve preparation, the theories of construction of cross-striated muscle fibers is enough to cause one to pause in stating that he is dealing with a case of "fundamentals." As for the nerve, we have again a highly specialized organ for the transmission of impulses, which bears many differentiations, totally unlike what exists in the lower forms where transmission of stimuli proceeds. For the medical student, for whom these courses are designed, nothing could be better and the success which this man obtains with his methods in inculcating the knowledge which should be a part of all medical training is indicative of the fact that he is on the right track.

However, for the biological student, the course is inadequate. There is a wealth of material which can be presented in actual laboratory work concerning the fundamentals of protoplasm in general and of irritability and contractility in particular. What is needed is the simple recognition, born of actual experience, that such possibilities exist. They are appreciated in various quarters and the writer has found them recognized in even a medical school within the limits of the city of Boston, where they are not alone appreciated, but actually incorporated into the medical curriculum, in a small way, to be sure, but nevertheless therein.

It is not within the purport of an article of this kind to attempt to outline the presentation of general, or biological physiology. It may be sufficient to say, however, that were the catholicity of view of the average botanist equally well developed in the students of zoology, there would be no demand, as seems actually to exist, for an outline of a course in general or, specifically, zoological physiology. It is not biologists in the strict sense of the word who need the education, but zoologists. The difficulty centering about this one group of scientists demands elucidation; why is it that the average student of zoology is less familiar with function than the student of botany?

The answer to this question must not be that the departments of botany, as we have said before, present functional studies, while the departments of zoology do not; that is not a reason. *The adequate reason lies in the point of view.* For the plant student, there is no line of demarcation between form and function. The structure of the leaf is taken as a matter of course in terms of transpiration and of photosynthesis; one is not complete without the other. In elementary botany, these functional considerations are presented. What course of elementary zoology, even of the college grades, teaches the student the rudiments of the most important of all the properties of organisms, namely, oxidation? The minutiae of the nervous system of the cray fish are followed, yet the simple fact which we have just mentioned must be delegated to another department for presentation, that is, to the physiologist.

Morphology has been adhered to in a large manner on account of its supposed superior pedagogical value. Here are things succinct and things one may feel and handle.

From the tangible to the intangible in the perfect method. For reasons such as these, morphological aspects have held the center of the stage. Additional reasons have been of historical nature. The science of biology is still concerned with the method of evolution; witness the "fashion" of genetics, so all-absorbing that the subject dominates the cementing society of biological societies—the naturalists, together with an organ, one of the first of its kind in this country, namely, *The American Naturalist.* Now genetics *can* apply and do apply, as has been shown abundantly, to function but, for class presentation, form is much easier. Following the enunciation of the so-called Darwinian Theory, came a long line of verifiers and exemplifiers, who piled up the mass of data which has been systematized into our modern conception of

how evolution works. Function played a minor rôle in these classic studies, comparative anatomy, comparative embryology, comparative paleozoology and paleo-botany—all concerned with form, holding the fort. Hence, it is quite natural that these subdivisions of biology should persist with a lion's share for a time. In fact the generation of comparative anatomists, comparative embryologists and other morphological students is still with us. When we consider that the so-called "experimentalist" school, arising with Roux, Morgan, Loeb and others, took its inception only somewhat over a score of years ago, and that this school has been the first to direct the attention of zoologists to fields other than those cultivated by the verifiers of Darwin, we should not wonder that the fundamental aspect of biology, as far as teaching is concerned, which changes slowly, is principally morphological.

Now it is an interesting suggestion that although the biologists following Darwin were distinctly students of form, the founder of the theory which bears his name, along with his immediate associates, such as his "Bull-dog, Huxley," were really more interested in function than in form. Darwin's studies in climbing plants, in mould formation and in other things which may be called "dynamic," were of the spirit of the physiologist; he was interested in the manner in which the things worked, rather than in the varieties of form. Huxley for his part lamented that his career had not carried him closer to physiology.

We have seen how morphological aspects dominated and still dominate biology, especially zoology, even in the face of the early appreciation of things dynamic by the men whose researches gave inception to our sciences of biology. We have now to learn why physiology has been so slow to become recognized by the zoologists.

Mammalian physiology has outstripped all other functional studies. The medical school has persisted as a continuum from the times of the Greeks. Moreover, we should recognize why it has existed as a continuum; its relation to the art of medicine has insured this. Given a subject which has intimate bearing upon not alone the welfare of the human individual, but upon his very life, we may well suppose that it will develop faster and receive more prompt attention than a subject which, although perhaps bearing likewise upon the welfare of man, yet does not do so directly. It is natural then that the medical physiologists should have the lion's share of function. Medicine, again, is intensely eclectic, hunting and prying into the uttermost corners of human experience for things which it may take to itself and make a part of its own fabric. Consequently, we have been deluded with the apparent catholicity of human physiology and have been resting securely in the belief that it would take care of all our functional problems, be they of human reference or more general. It is true that the human physiologists have contributed largely to all that is worth while in functional studies. It is likewise true that they have failed to pursue the enigma beyond their own field save in isolated cases. They have always been interested in the cell studies of the biologist, but their contributions have been meager. We have instances, such as the classic researches of Fr. Miescher upon the cells of pus formation, out of which came our modern conception of the construction of nucleic acid at the hands of Jones and P. A. Levine; the studies of Claude Bernard upon oxidation of sugars; the fundamental studies of energetics (or thermodynamics) of Rubner, Atwater, Benedict and others; yet these studies are but instances and emphasize the paucity of contributions of medical physiologists to the fundamental problems of the cell, which, if we agree with the great pathologist, Rudolf Virchow, represents the *terminus ad quem* of all biological work, be it "biological," botanical, zoological, medical, or what-not.

The fact remains, then, that if the zoologist is to round out his science, making it equivalent for animals what botany is for plants, he can not expect the medical physiologist to take care of his problems in animal function. Comparative physiology, which has received a strong impetus in the "Handbuch" of Winterstein and in that of Jordan, will never

thrive in the medical school; there is no place for it and the tendency in the modern medical curriculum is to eliminate rather than to add to the already over-crowded subject list. Moreover, general physiology will find no place, for the aspect of functional study is from the top downward, from man towards the lower groups; the cell will continue to be treated as an interesting organ, even as the liver is considered, but its study will progress in the medical laboratories only so far as the problems are of medical importance of a more immediate nature.

What, then, is to become of general, or what we may term zoological, physiology, granting that botanical physiology is in good hands?

There are no agencies, save a very few, whereby a prospective student of zoological physiology can gain the training necessary for his work. We must eliminate the medical courses in physiology and in physiological chemistry. Zoology must recognize the importance of taking care of its own ground and develop means of deriving a line of zoological physiologists. It must cease to permit men like our Gortners, McClendons, Mathewses, Lyons and others to be taken by the medical and other professional schools from biology into lines where their promises as students of fundamentals cease. Unless this is done, the considerate criticisms, such as the one we have referred to at the beginning of the present communication, that modern biology is in a parlous way; that it is unproductive and dealing with blue ethereal theories, and that its face, which should be directed as that of Janus, before and backward, is cast towards the old, rather than the new.

What the agencies must be which will be capable of bringing biology into line with its sister science, is a matter of lengthy discussion. The conditions are ripe for the production of a new order of work in dynamic biology, for the methods which have been worked out within recent years at the hands of Winterstein, Folin, Taschiro, Van Slyke, and others —the so-called "micro" methods applicable to small material afford an excellent place for beginning. Thus far the field is practically virgin. From the investigation side, then, we are ready. From the pedagogical aspect, as Mark Twain remarked about the weather, the discussion is plentiful, but nothing is done; zoologists want the development of more function, but they do not know what to do about it. Not trained themselves to carry classes in the subject, they are at a loss as to the method of procedure. There is but one way: Induce students entering biology to specialize as best they may to fill positions in dynamic biology and reward their efforts when they have been successful by instructorships and higher positions in their turn, in the departments of zoology. This programme has been actually put into force in one university. The great desideratum, however, is that the opportunities be more attractive than those offered by the medical departments of physiology and biochemistry.[2] Otherwise the same gravitations to these schools will take place as in the past. It is not a matter of salary altogether; it is mainly the creation of the appreciation for the work of these students. Again, it is undesirable that the studies should involve complicated apparatus, unfamiliar and expensive chemicals, etc. The simpler the more efficient will the work become. The plant physiological apparatus and methods of men such as Professor Genung are simple, inexpensive and readily appreciated by the student; the same should apply to general physiological methods and apparatus. It is not necessary to measure the hydrogen ion concentration in a class of this nature, especially where it is desirable to do so by complicated means, such as by a potentiometer for E.M.F. In this one instance, we have the extremely simple method, if it is necessary at all to present the matter to a class in functional zoology, of Marriott. Much better than any, is to eliminate the methods necessitating a fairly high degree of previous experience in physics and chemistry; enough will remain of fundamental importance which may be studied by the microscope, the test-tube and a few simple pieces of apparatus.

[2] The writer is using the words of the late Professor F. P. Mall.

It is only by such means that biology is to maintain its place. The science has justified its existence, to be sure, in the unravelling of the complicated skein of genetics and sex. However, to eliminate criticism concerning the ability of zoologists to speak glibly of enzymes and catalyzers, or sex hormones and of chemical determiners, they should fortify themselves by a strong development of functional biology.

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SCIENTIFIC EVENTS

AURORA AND MAGNETIC STORM OF MARCH 7-8 IN ENGLAND

THE auroral display is said to have attracted much attention, partly because it coincided with an air-raid upon London. The northern sky was lighted up with a crimson glow both before and during the raid, which started shortly after 11 P.M.; and the appearance was thought by an observer at Folkstone to be due to a distant fire. Sir Napier Shaw informs *Nature* that the Meteorological Office has received reports of aurora observations from Lerwick, Stornoway, Eskdalemuir, Donaghadee, Liverpool, Clacton and Southend, and forwarded the following account, by Dr. C. Chree, of the large magnetic disturbance recorded at the Kew Observatory between 9 P.M. on Thursday and 5 A.M. on the following morning. Mr. A. Lander has sent *Nature* photographic traces of movements in declination recorded at Canterbury during Thursday and Friday. Thursday's trace was remarkably even until shortly after 9 P.M., when the magnetic storm began. *Nature* remarks that it is possible that the disturbance was a repetition, after three 27-day intervals, of the large magnetic storm of December 16–17, 1917. There was a very considerable disturbance on January 12 at the end of the first 27-day interval, and a minor disturbance at the end of the intermediate interval in February.

Dr. Chree wrote: "A magnetic storm of no great duration, but very considerable amplitude, was recorded at Kew Observatory on the night, March 7–8, 1918. It began with a 'sudden commencement' at about 9h. 10m. P.M. on March 7. The largest movements occurred in the early morning of March 8, between midnight and 5 A.M., but smaller oscillations persisted for some time after the latter hour. The 'sudden commencement' was especially prominent in horizontal force (H); after a small, sudden fall there was a sharp rise of fully 60γ. The corresponding movements in declination (D) consisted of an oscillation of about 4′, the first movement being to the west. The range shown on the D trace was about 51′, the extreme easterly and westerly positions being reached at 2.20 A.M and 4.16 A.M. respectively on March 8. Between 1.11 A.M. and 2.20 A.M. of the same day there was a movement of 36′ to the east. The range on the H trace was about 240γ. A very rapid downward movement commenced about 2.3 A.M. on March 8, the fall during the next thirty minutes amounting to fully 185γ. After 5 A.M. on the same day there were only short-period oscillations in H of moderate size; but up to 10 A.M. the element remained depressed by fully 70γ as compared with its value on the previous day before the storm."

THE STEAM ENGINEERING TRAINING SCHOOL AT THE STEVENS INSTITUTE

THE Navy Department has designated the Stevens Institute of Technology, Hoboken, N. J., as the headquarters for the new United States Naval Steam Engineering School for the training of engineer officers for the U. S. Naval Auxiliary Reserve.

This school is the only one devoted to training engineer officers for *steam-engine service,* and is a branch of the large training school now located at Pelham Bay Park, New York. There is at Pelham, in addition to the school for general training of enlisted men, an Officers' Material School, Naval Auxiliary Reserve. Both the school at Pelham and the engineer officer school at Stevens are under the supervision of the Supervisor, Naval Auxiliary Reserve. The education of the engineer officers at Stevens is directed by Professor F. L. Pryor, of Stevens, who has been appointed